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Declaration

I, Nicholas Hartmann, translator, having an office at 611 N. Broadway, Suite 509, Milwaukee, WI, 53202, declare that I am well acquainted with the English and German languages and that the appended document is a true and faithful translation of:

International Patent Application PCT/EP03/10139 entitled

"Außenläufermotor, und Verfahren zum Zusammenbau eines solchen"

[External-rotor motor, and method for assembling such a motor]

All statements made herein are to my own knowledge true, and all statements made on information and belief are believed to be true; and further, these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the document.

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EXTERNAL-ROTOR MOTOR AND METHOD FOR ASSEMBLING SUCH A MOTOR

The invention concerns an external-rotor motor, and it concerns a method for assembling an external-rotor motor.

In many external-rotor motors, the shaft of the external rotor is supported in a so-called bearing support tube on whose outer side a stator lamination stack is mounted. The shaft is usually mounted on the hub of a so-called rotor cup, and is supported within the bearing support tube by means of bearings, e.g. sintered bearings or rolling bearings. The type of bearing system depends principally on the desired service life of the motor and the desired smoothness.

For installation of the shaft, the bearing support tube usually has, on its side facing away from the rotor cup, an opening where components are located that serve to retain or support the shaft, e.g. a thrust bearing, spring member, retaining washer, bearing cover, or the like. Dirt can penetrate through this opening and shorten the service life of such a motor. Time is also needed for assembly, making such motors more expensive.

It is therefore an object of the invention to make available a novel external-rotor motor, and a new method for assembling such a motor.

According to a first aspect of the invention, this object is achieved by means of an external-rotor motor according to claim 1.

In such a motor, the bearing support tube can be largely closed, so that dirt cannot penetrate there.
It is also inexpensive to install.

According to another aspect of the invention, this object is achieved by means of the subject matter of claim 7. Assembly in this fashion requires only a small number of working steps and can be largely or even completely automated. An advantageous refinement of this method is the subject matter of claim 8. The risk of damage to the rolling bearings upon installation is thus reduced.

Further details and advantageous refinements of the invention are evident from the exemplary embodiment, in no way to be understood as a limitation of the invention, that is described below and depicted in the drawings, and from the dependent claims. In the drawings:

FIG. 1 depicts, in longitudinal section, the essential parts of the external rotor of an external-rotor motor;

FIG. 2 is a depiction analogous to FIG. 1 in which, however, various elements for a subsequent installation operation are pre-installed on the shaft of the external rotor;

FIG. 3 is a longitudinal section through a bearing support tube provided on the stator of the motor, viewed along line III-III of FIG. 4;

FIG. 4 is a plan view of the open, proximal end of the bearing support tube, viewed in the direction of arrow IV of FIG. 3;

FIG. 5 is a depiction analogous to FIG. 4 in which, however, a circuit board and a stator lamination stack provided with a stator winding are pre-installed on the bearing support tube;

FIG. 6 is a schematic depiction showing a snapshot during the "marriage" of stator and rotor;

FIG. 7 is a longitudinal section through an assembled motor that can be used, for example, to drive an equipment fan;

FIG. 8 is a section through a so-called retaining washer, viewed along line VIII-VIII of FIG. 9; and

FIG. 9 is a plan view of the retaining washer, viewed in the direction of arrow IX of FIG. 8.

FIG. 1 shows an external rotor 22 for an external-rotor motor 20 as depicted in FIG. 7. External rotor 22 has a rotor cup 24 that is usually manufactured from plastic or a lightweight metal.

The parts that are facing toward rotor cup 24 will be referred to hereinafter, by analogy with medical terminology, as "proximal," and the parts facing away from rotor cup 24 as "distal."

Mounted in the center of rotor cup 24, i.e. on its hub 36, is proximal end 26 of a shaft 28 at the distal end of which is provided an annular groove 30 that serves, as shown in FIG. 2, for mounting of a snap ring 32. The distal end of shaft 28 is labeled 34. Shaft 28 has a cylindrical cross section, and its diameter is constant over practically the entire length. Located on hub 36 is an axial projection 38 that protrudes in the distal direction away from hub 36 and has a depressed region 39 in its center.

A magnetic yoke in the form of a sheet-metal ring 40 made of soft iron is mounted in rotor cup 22, and on the ring's inner side is located a (usually flexible) ring 44 made of permanent-magnetic material, usually a so-called rubber magnet, i.e. a mixture of ferromagnetic particles and an elastomer. Ring 44 is magnetized in the radial direction with the requisite number of magnetic poles, e.g. with four poles as is common practice in the art.

As shown in FIG. 2, a variety of components are pre-installed on shaft 28 prior to the assembly of motor 20.

Beginning at projection 38, the first is a compression spring 48 of approximately conical shape whose proximal, larger-diameter end lies in depression 39.

Following spring 48 in the distal direction is an annular retaining member in the form of a retaining washer 50,

as described in more detail below with reference to FIGS. 8 and 9. Spring 48 preferably is not in contact against this retaining member 50.

Retaining member 50 is followed by a proximal rolling bearing 52 comprising an outer ring 54 and an inner ring 56. The latter is displaceable in the axial direction on shaft 28 with a small clearance. The distal end of spring 48 is in contact against the proximal end of inner ring 56. Rolling bearing 52 is followed in the distal direction by a spacer 58, which is guided displaceably on shaft 28 by means of a radially inwardly protruding projection 59, and whose proximal end is in contact, as depicted, against the distal end of outer ring 54.

Spacer 58 is followed by a distal rolling bearing 60 comprising an outer ring 62 that is in contact with its proximal end against spacer 58, and comprising an inner ring 64 that is displaceable in the axial direction on shaft 28 with a small clearance and is in contact with its distal end, as depicted, against snap ring 32 when motor 20 is completely assembled. (Optionally, a spacer or the like can also be located between snap ring 32 and rolling bearing 60, e.g. in order to compensate for tolerances.)

It is immediately apparent that by pressing with a force F in the proximal direction on distal rolling bearing 60, spring 48 can be compressed and the two rolling bearings 52 and 60, spacer 58, and retaining washer 50 can be displaced in the proximal direction on shaft 28, so that inner ring 64 is no longer in contact against snap ring 32 but becomes spaced away from it. In this case projection 38 of rotor cup 24 comes into contact against retaining washer 50 and allows an axial force to be transferred via the latter, in the distal direction, onto retaining washer 50, outer ring 54, spacer 58, and outer ring 62 when rotor cup 24 is pressed downward, i.e. in the distal direction, by a force K upon assembly. This is depicted below in FIG. 6.

FIG. 3 shows bearing support tube 70 of external-rotor motor 20, which tube is usually manufactured from plastic or a lightweight metal. In this embodiment it has at the bottom a flange 72 that serves to mount motor 20, e.g. to mount it on a fan housing or some other device to be driven.

Bearing support tube 70 has on its outer side a shoulder 74, and adjacent thereto in the proximal direction a circumferential surface 76 that tapers toward the top in frustoconical fashion.

On its inner side 78, bearing support tube 70 has six longitudinal ribs 80 that end at a distance d from the closed distal end 82 of bearing support tube 70. They are followed in the distal region by a total of eight ribs 84 whose proximal ends form, during assembly, a stop for outer ring 62 of distal ball bearing 60 (see FIG. 7). These ribs 84 taper in the proximal direction so that distal end 34 of shaft 28 has sufficient room during assembly (see FIG. 6). The bearing support tube has projections 86 at its upper, proximal end (see FIG. 6).

FIG. 5 shows the manner in which a stator lamination stack 90 is mounted on bearing support tube 70. Lamination stack 90 has for this purpose a coil former 92 made of plastic into which a stator winding 94 is wound. A circuit board is indicated at 93. FIG. 5 shows two winding ends 95, 96 that are soldered respectively onto an associated metal pin 98 and 97. Coil former 92 has, as depicted, an inwardly protruding projection 100 with which it is pressed onto outer side 76 of bearing support tube 70.

FIG. 6 shows a snapshot, so to speak, during the "marrying" operation in which shaft 28 of rotor 22, with rolling bearings 52, 60 located thereon, is introduced for the first time into inner recess 78 (see FIG. 3) of bearing support tube 70.

In this context, a force K is applied in the distal direction onto rotor 22, and because outer rings 54, 62 of rolling bearings 52, 60 are pressed with a press fit into ribs 80 (see FIG. 3) of bearing support tube 70, spring 48 is compressed by force K so that shaft 28 is displaced in the distal direction within ball bearings 52, 60, and projection 38 pushes via retaining washer 50 on outer ring 54 of ball bearing 52, and via spacer 58 also on outer ring 62 of ball bearing 60, and thus presses the two ball bearings 52, 60 into bearing support tube 70. As depicted in FIG. 6, spring 48 is only partly compressed in this process in order to prevent damage to it.

The pressing-in operation continues until outer ring 62 of distal ball bearing 60 is in contact against the proximal ends of ribs 84.

In this context, as depicted, retaining member 50 is displaced in bearing support tube 70 in the distal direction, i.e. downward, and digs into the material of bearing support tube 70 so that the entire bearing arrangement is latched or locked in bearing support tube 70. If an attempt were made to pull rotor 22 out of bearing support tube 70 oppositely to force K, retaining member 50 would only dig that much more deeply into the material of bearing support tube 70, so that the attachment here is therefore extraordinarily secure. There are, of course, many different solutions and components for a permanent latching system of this kind, and retention member 50 that is depicted therefore represents only a preferred embodiment.

After the pressing-in operation is complete, force K is removed and the result then is as shown in FIG. 7, i.e. spring 48 again presses shaft 28 upward in the proximal direction until snap ring 32 is again in contact against inner ring 64 of distal rolling bearing 60. The marriage is then complete. Spring 48 now clamps the two inner rings 56, 64 of rolling bearings 52, 60 against one another, which is favorable in terms of quiet operation of motor 20.

FIG. 8 and 9 show a preferred embodiment of a retaining member 50. This has in the middle an opening 110 for the passage of shaft 28 and of the distal end of compression spring 48. Opening 110 is located in a flat part 112 that is adjoined toward the outside by a frustoconical portion 114 whose upper (in FIG. 8) end 116 digs into the material of bearing support tube 70 upon assembly because its diameter is greater than the inside diameter of bearing support tube 70.

Portion 114 could be divided, by slots that extend in the axial direction, into a plurality of individual prongs. In this case an annular retaining member of this kind can also be referred to as a prong washer or prong ring. It is usually not necessary, however, to provide such individual prongs. It can also be very advantageous to implement spring 48 and retaining member 50 together as a single component. These parts can, for example, be welded together, or spring 48 can be machined directly out of the material of retaining washer 50. In other ways as well, many variants and modifications are possible in the context of the present invention.